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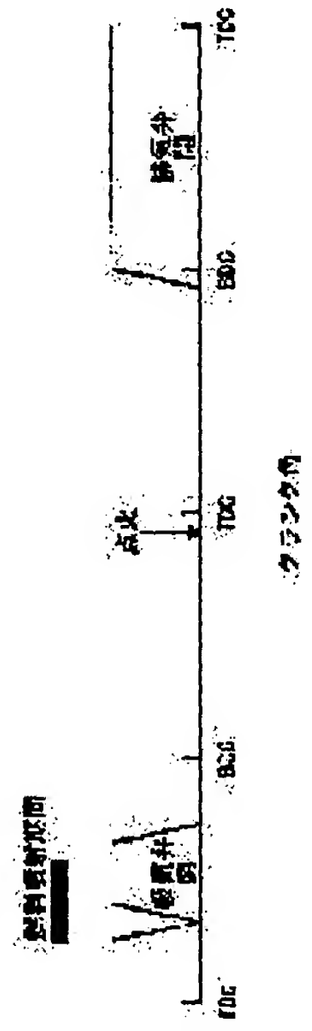
(54) COMBUSTION CONTROL DEVICE FOR INTERNAL COMBUSTION ENGINE

(57)Abstract:
PROBLEM TO BE SOLVED: To raise the effective compression ratio to improve combustion by stratifying EGR gas and fresh air in an internal combustion engine provided with electromagnetically-operated intake valves and exhaust valves and performing non-throttle operation.
SOLUTION: For a specified period after completion of an exhaust stroke (exhaust top dead centre), either one exhaust valve of two exhaust valves provided at one cylinder, is opened to such back exhaust gas to the combustion chamber to impart swirl to the exhaust gas (EGR gas). In an intake stroke after an exhaust valve is closed, or in a compression stroke, in a state of negative pressure in the combustion chamber, an intake valve out of two intake valves provided at one cylinder on a diagonal line of an exhaust valve is opened to such fresh air into the combustion chamber, to impart swirl to the fresh air. Fuel is injected from a fuel injection valve so as to carry the fuel with the swirl flow of the fresh air.



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* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] the electromagnetism characterized by providing the following -- the internal combustion engine which controls an inhalation air content by having the inlet valve and exhaust valve of a drive formula, and controlling the open period of an inlet valve An exhaust air valve-control means for an exhaust air line to open a predetermined period and an exhaust valve also for after an end, and to return exhaust air to a combustion chamber. An exhaust air swirl grant means to give a swirl to the exhaust air returned to a combustion chamber. Inlet-valve control means which open an inlet valve and will inhale new mind to a combustion chamber by ignition timing after valve closing of an exhaust valve. A new mind swirl grant means to give a swirl to the new mind inhaled to a combustion chamber, and fuel-injection control means which make fuel inject from a fuel injection valve so that it may put in the style of [of the aforementioned new mind] a swirl.
[Claim 2] The aforementioned exhaust air swirl grant means is the combustion control system of the internal combustion engine according to claim 1 characterized by opening only one exhaust valve among the exhaust valves which it has, and giving a swirl by the two aforementioned exhaust air valve-control meanses per cylinder.
[Claim 3] The aforementioned new mind swirl grant means is the combustion control system of the internal combustion engine according to claim 2 characterized by opening only aforementioned one exhaust valve and the inlet valve on the diagonal line among the inlet valves which it has, and giving a swirl by the two aforementioned inlet-valve control means per cylinder.
[Claim 4] The aforementioned inlet-valve control means are the combustion control systems of the internal combustion engine of any one publication of the claim 1 characterized by opening an inlet valve and inhaling new mind in the intake stroke after valve closing of an exhaust valve at a combustion chamber - the claim 3.
[Claim 5] The aforementioned inlet-valve control means are the combustion control systems of the internal combustion engine of any one publication of the claim 1 characterized by opening an inlet valve and inhaling new mind to a combustion chamber in a compression stroke on the conditions to which negative pressure exists in a combustion chamber - the claim 3.

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* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention -- electromagnetism -- it has the inlet valve and exhaust valve of a drive formula, and is related with the combustion control system of an internal combustion engine (Miller cycle engine) which performs non throttle operation
[0002]
[Description of the Prior Art] a purpose [improvement / by reduction of a recent-years and pump loss / in mpg] -- carrying out -- electromagnetism -- it has the inlet valve and exhaust valve of a drive formula, and an inhalation air content is controlled by controlling the open period of an inlet valve, and the internal combustion engine (Miller cycle engine) which performs non throttle operation attracts attention
[0003] Although it is not one of these, and a mirror cycle, as shown in JP,5-321702,A It has the valve timing means for switching which can switch the valve timing of an inlet valve and an exhaust valve to the low-speed valve timing suitable for the low rotation field, and the high-speed valve timing suitable for the high rotation field. By making an exhaust valve close in the middle of like an exhaust air line, and making an inlet valve open from the middle of an intake stroke, when the aforementioned valve timing is set as low-speed valve timing Raise a piston, while the exhaust air line had stopped combustion gas in the cylinder from the middle, and it compresses. go into an intake stroke and a piston descends -- cylinder internal pressure -- atmospheric pressure and abbreviation -- as an inlet valve is made to open when it becomes the same, and new mind is made to flow on the combustion gas (internal-EGR gas) which remains in a cylinder, there are some which attained stratification-ization with EGR gas and new mind
[0004]
[Problem(s) to be Solved by the Invention] By the way, when performing non throttle operation using a mirror cycle, in a low load region, the open period of an inlet valve is very short, from the bird clapper, the effective compression ratio decreased, combustion got worse, and there was a trouble that the improvement effect in mpg will lose in weight. Then, it left EGR gas in the cylinder, EGR gas and new mind were stratification-ized, the amount of working medium was increased, the effective compression ratio was raised, and it was possible to aim at a combustion improvement.
[0005] although the technology given [as technology] in the aforementioned official report which attains stratification-ization with EGR gas and new mind by control of valve timing is known, since closed timing of an exhaust valve is made into the early stage in front of an exhaust air top dead center, a pump loss becomes large Moreover, since generation of a swirl and optimization of fuel-injection timing are omitted, stratification-izing [of a gaseous mixture] becomes inadequate.
[0006] such [this invention] the actual condition -- taking an example -- electromagnetism -- it has the inlet valve and exhaust valve of a drive formula, and in the internal combustion engine (Miller cycle engine) which performs non throttle operation, while raising an effective compression ratio and aiming at a combustion improvement by stratification-ization with EGR gas and new mind, it aims at enabling it to suppress increase of a pump loss
[0007]
[Means for Solving the Problem] In the internal combustion engine which controls an inhalation air content by having the inlet valve and exhaust valve of a drive formula, and controlling the open period of an inlet valve for this reason -- invention concerning a claim 1 -- electromagnetism -- An exhaust air line by ignition timing after an exhaust air valve-control means by which after an end opens a predetermined period and an exhaust valve, and returns exhaust air to a combustion chamber, an exhaust air swirl grant means to give a swirl to the exhaust air which returns to a combustion chamber, and valve closing of an exhaust valve The inlet-valve control means which open an inlet valve and inhale new mind to a combustion chamber, and a new mind swirl grant means to give a swirl to the new mind inhaled to a combustion chamber, The fuel-injection control means which make fuel inject are prepared, and the combustion

control system of an internal combustion engine consists of fuel injection valves so that it may put in the style of [of the aforementioned new mind] a swirl.

[0008] That is, while an exhaust air line opens a predetermined period and an exhaust valve also for after an end (exhaust air top dead center) and returns exhaust air to a combustion chamber, it gives a swirl to this exhaust air (EGR gas). And while opening an inlet valve by ignition timing and inhaling new mind to a combustion chamber, a swirl is given to this new mind and fuel is made to inject from a fuel injection valve further, after valve closing of an exhaust valve, so that it may put in the style of [of this new mind] a swirl.

[0009] A gaseous mixture can be stratification-ized good to the exhaust air up side by exhaust air (EGR gas) being located in the combustion-chamber bottom, and locating the gaseous mixture of new mind and fuel in the bottom, and generating a swirl style by doing in this way, without producing disorder of lengthwise. Therefore, the amount of working medium can be increased, an effective compression ratio can be raised, and a combustion improvement can be aimed at, and a combustion improvement can be aimed at also by the temperature rise of the gaseous mixture by heat-receiving from hot exhaust air. Moreover, compared with the case where an exhaust air line closes an exhaust valve on the way, and limits combustion gas to a combustion chamber, the pump loss by compression (recess of the heat by the temperature rise) of combustion gas can be reduced.

[0010] In invention concerning a claim 2, the aforementioned exhaust air swirl grant means is characterized by opening only one exhaust valve among the exhaust valves which it has, and giving a swirl by the two aforementioned exhaust air valve-control meanses per cylinder. In invention concerning a claim 3, the aforementioned new mind swirl grant means is characterized by opening only aforementioned one exhaust valve and the inlet valve on the diagonal line among the inlet valves which it has, and giving a swirl by the two aforementioned inlet-valve control means per cylinder.

[0011] In invention concerning a claim 4, the aforementioned inlet-valve control means are characterized by opening an inlet valve and inhaling new mind in the intake stroke after valve closing of an exhaust valve, at a combustion chamber. In invention concerning a claim 5, the aforementioned inlet-valve control means are characterized by opening an inlet valve and inhaling new mind to a combustion chamber in a compression stroke, on the conditions to which negative pressure exists in a combustion chamber.

[0012]

[Effect of the Invention] While according to invention concerning a claim 1 being able to attain stratification-ization of a gaseous mixture to the exhaust gas (EGR gas) up side in a combustion chamber, being able to increase the amount of working medium, being able to raise an effective compression ratio and being able to aim at a combustion improvement by control of the valve timing of an exhaust valve and an inlet valve, generation of a swirl, and optimization of fuel-injection timing, increase of a pump loss can be suppressed.

[0013] According to invention concerning a claim 2, only one exhaust valve is opened among the exhaust valves which it has two per cylinder, and it can carry out easily by giving a swirl to the exhaust air to return, without forming a special valve gear. Without forming a special valve gear by opening only one inlet valve among the inlet valves which it has two per cylinder, and giving a swirl to the new mind to inhale according to invention concerning a claim 3, by being able to carry out easily and considering as the exhaust valve for swirl grant, and the inlet valve on the diagonal line, a swirl can be promoted and stratification-ization becomes fitness more.

[0014] According to invention concerning a claim 4, a pump loss can be reduced more by setting the open timing of an inlet valve as the intake stroke after an exhaust-valve-closes valve. Since according to invention concerning a claim 5 new mind can be inhaled with sufficient vigor with negative pressure, and a gas flow can be strengthened and the time to ignition becomes short by setting the open timing of an inlet valve as the conditions to which negative pressure exists in a combustion chamber in a compression stroke, it becomes easy to maintain a stratification state.

[0015]

[Embodiments of the Invention] The gestalt of operation of this invention is explained based on a drawing below. The system chart of the internal combustion engine which drawing 1 shows the operation gestalt of this invention, and drawing 2 are the outline plans of an internal combustion engine. an ignition plug 4 is surrounded in the combustion chamber 3 formed by the piston 2 of each cylinder of an internal combustion engine 1 -- as -- every two-piece electromagnetism -- it has the inlet valves 5A and 5B and exhaust valves 6A and 6B of a drive formula 7 is an inhalation-of-air path and 8 is a flueway.

[0016] the electromagnetism of inlet valves 5A and 5B and exhaust valves 6A and 6B -- the basic structure of a driving gear is shown in drawing 3 The plate-like needle 22 is attached in the valve stem 21 of a valve element 20, and this needle 22 is energized by the center valve position with springs 23 and 24. and this needle 22 bottom -- the object for valve opening -- electromagnetism -- a coil 25 arranges -- having -- a top -- the object for valve closing -- electromagnetism -- the coil 26 is arranged

[0017] therefore, the time of making it open -- the object for upper valve closing -- electromagnetism -- the object for valve opening of the bottom after stopping the energization to a coil 26 -- electromagnetism -- the lift of the valve element 20 is carried out, and it is made to open by energizing in a coil 25 and adsorbing a needle 22 with the down side on the contrary, the time of making the valve close -- the object for lower valve opening -- electromagnetism -- the object for valve closing of the bottom after stopping the energization to a coil 25 -- electromagnetism -- the sheet section is sat and a valve element 20 is made to close by energizing in a coil 26 and adsorbing a needle 22 with the up side

[0018] It returns to drawing 1 and the electromagnetic fuel injection valve 9 is formed in the inhalation-of-air path 7 at the suction-port portion for every cylinder. In here the operation of inlet valves 5A and 5B, exhaust valves 6A and 6B, a fuel injection valve 9, and an ignition plug 4 It is controlled by the control unit 10. to this control unit 10 Synchronizing with engine rotation, output a crank angle signal, and from the air flow meter 13 grade which detects an inhalation air content at the crank angle sensor 11 which can detect an engine rotational frequency by this, the accelerator pedal sensor 12 which detects accelerator opening (the amount of trodding of an accelerator pedal), and the inhalation-of-air path 7 The signal is inputted.

[0019] An exhaust air swirl grant means and a new mind swirl grant means consist of an exhaust air valve-control means, inlet-valve control means, and fuel-injection control means being constituted by this control unit 10, and opening only one of the two's exhaust valve and inlet valve on the occasion of an exhaust air valve control and inlet-valve control. Drawing 4 shows the flows of control performed with the microcomputer in a control unit 10.

[0020] Step 1 (it is described in drawing as S1.) In it being the same as that of the following, the open timing (EVO) of an exhaust valve is set up for example, near a bottom dead point (BDC). That is, it is set as the open timing from which thermal efficiency serves as best according to a target air content. At Step 2, the closed timing (EVC) of an exhaust valve is set up in a predetermined period (inside of an intake stroke) from a top dead center (TDC).

[0021] In addition, the opening-and-closing timing of the exhaust valve set up here is about one exhaust valve 6A, and suppose that it has closed, or it is made to open near a bottom dead point (BDC), and the valve is made to close near a top dead center (TDC) about exhaust valve 6B of another side. At Step 3, the open timing (IVO) of an inlet valve is set up into the intake stroke just behind the closed timing (EVC) of an exhaust valve.

[0022] At Step 4, a target air content (target inhalation air content) is calculated based on accelerator opening (load) and an engine rotational frequency. At Step 5, according to a target air content, the closed timing (IVC) of an inlet valve is set up so that there are many target air contents and it may delay. In addition, the opening-and-closing timing of the inlet valve set up here is about aforementioned one exhaust valve 6A and inlet-valve 5B on the diagonal line, and presupposes that it has closed except for a heavy load region about inlet-valve 5A of another side.

[0023] At Step 6, it is made to correspond to the open period of an inlet valve, and the fuel-injection timing of a fuel injection valve is set as timing a little earlier than the open timing of an inlet valve so that fuel may be carried by the air inhaled by the combustion chamber. At Step 7, a real air content (real inhalation air content) is detected based on the signal from an air flow meter.

[0024] At Step 8, to a real air content, the fuel oil consumption (injection time) of a fuel injection valve is calculated so that it may become a predetermined air-fuel ratio. It is made to operate to timing as shown in drawing 5 and drawing 6 by such setup. That is, although an exhaust valve is opened like an exhaust air line, an exhaust air line makes after an end (TDC) open between place commuter's tickets about one exhaust valve 6A. The inlet valve has been closed at this time. Therefore, while exhaust air is returned by the combustion chamber from one exhaust valve 6A with descent of a piston, an exhaust air swirl style is generated by the combustion chamber.

[0025] And only the exhaust valve 6A and inlet-valve 5B on the diagonal line are made to open after the aforementioned predetermined period and immediately after closing exhaust valve 6A. Thereby, while new mind is inhaled by the combustion chamber from the inlet-valve 5B with descent of a piston, a new mind swirl style is generated by the combustion chamber. Thus, by generating the swirl style of this direction, an exhaust air swirl style is formed in the combustion-chamber bottom, a new mind swirl style is independently formed in the bottom, respectively, and it is maintained.

[0026] Moreover, since it is made to correspond to the open period of an inlet valve, injection fuel is carried by new mind by making the fuel injection of a fuel injection valve perform to the optimal timing and it mixes,-izing of the gaseous mixture can be carried out [stratification] to the combustion chamber headroom by the side of an ignition plug. Then, when the new mind of the amount corresponding to the target air content was inhaled, it becomes the closed timing of an inlet valve and inlet-valve 5B closes in the middle of an intake stroke. Then, it shifts to a compression stroke, and in front of a compression top dead center (TDC), it is lit by the gaseous mixture of a stratification state by the ignition plug, and burns.

[0027] As the PV diagram in this case is shown in drawing 7 , a next door and a pump loss are reduced. Other

operation gestalten of the following this invention are explained. With this operation gestalt, the open timing (IVO) of an inlet valve is set as the conditions to which negative pressure exists in a combustion chamber in a compression stroke in Step 3 of the flows of control of drawing 4 .

[0028] It is made to operate to timing as shown in drawing 8 and drawing 9 by such setup. That is, although an exhaust valve is opened like an exhaust air line, an exhaust air line makes after an end (TDC) open between place commuter's tickets about one exhaust valve 6A. The inlet valve has been closed at this time. Therefore, while exhaust air is returned by the combustion chamber from one exhaust valve 6A with descent of a piston, an exhaust air swirl style is generated by the combustion chamber.

[0029] And after the aforementioned predetermined period, although exhaust valve 6A is closed, the inside of an intake stroke maintains an inlet valve in the valve-closing state. Therefore, a combustion chamber serves as negative pressure by descent of a piston. When a combustion chamber is still negative pressure, only aforementioned one exhaust valve 6A and inlet-valve 5B on the diagonal line are made to open in a predetermined period, after shifting to a compression stroke. Thereby, while new mind is inhaled with sufficient vigor by the combustion chamber from the inlet-valve 5B, a new mind swirl style is generated by the negative pressure of a combustion chamber at a combustion chamber. Thus, by generating the swirl style of this direction, an exhaust air swirl style is formed in the combustion-chamber bottom, a new mind swirl style is independently formed in the bottom, respectively, and it is maintained.

[0030] Moreover, since it is made to correspond to the open period of an inlet valve, injection fuel is carried by new mind by making the fuel injection of a fuel injection valve perform to the optimal timing and it mixes,-izing of the gaseous mixture can be energized and carried out [stratification] to the combustion chamber headroom by the side of an ignition plug. Then, when the new mind of the amount corresponding to the target air content was inhaled, it becomes the closed timing of an inlet valve and inlet-valve 5B closes in the middle of a compression stroke. Then, in front of a compression top dead center (TDC), it is lit by the gaseous mixture of a stratification state by the ignition plug, and burns.

[0031] it seems that the PV diagram in this case is shown in drawing 10 -- ** -- it becomes Although there is disadvantage of that a pump loss increases, inhalation-of-air sound getting worse compared with the above-mentioned operation gestalt, since new mind can be inhaled with sufficient vigor with negative pressure, and a gas flow can be strengthened and the time to ignition becomes short, there is an advantage of being easy to maintain a stratification state. In addition, when equipping the inhalation-of-air path 7 with the swirl control valve 14 and closing one suction port substantially at the time of the operation as shown in drawing 11 although only one inlet valve was opened in case a new mind swirl is formed, two inlet valves 5A and 5B are synchronized mutually, and you may make it open and close them with the above operation gestalt. In this case, in case an exhaust air swirl is generated, only inlet-valve 5B which inhales new mind corresponding to the suction port always opened by the swirl control valve 14, and exhaust valve 6A on the diagonal line are opened.

[0032] Moreover, although the fuel injection valve 9 is arranged to the inhalation-of-air path 7 and considered as the composition which carries out port injection with the above operation gestalt, the fuel injection valve of the direct injection formula which injects direct fuel may be used for a combustion chamber, and although injection fuel is put in the style of [of new mind] a swirl in this case, most restrictions of injection timing are lost.

[0033]
 [Comparative Example(s)] Finally the example of comparison is described. Drawing 12 shows the example 1 of comparison, makes closed timing of an exhaust valve predetermined period before from an exhaust air top dead center (TDC) to drawing 5 and the 1st operation gestalt of drawing 6 , is bringing the closed timing of an exhaust valve forward, and limits combustion gas to a combustion chamber.

[0034] Drawing 13 shows the example 2 of comparison, makes closed timing of an exhaust valve predetermined period before from an exhaust air top dead center (TDC) to drawing 8 and the 2nd operation gestalt of drawing 9 , is bringing the closed timing of an exhaust valve forward, and limits combustion gas to a combustion chamber. it seems that the PV diagram in the case of a next door and the example 2 (drawing 13) of comparison is shown in drawing 15 here as the PV diagram in the case of the example 1 (drawing 12) of comparison is shown in drawing 14 -- ** -- it becomes In the case of the examples 1 and 2 of comparison, a pump loss will increase so that these may show. Moreover, since exhaust air is not returned, it is difficult to give a swirl and it becomes inadequate stratification-izing it.

[Translation done.]

* NOTICES *

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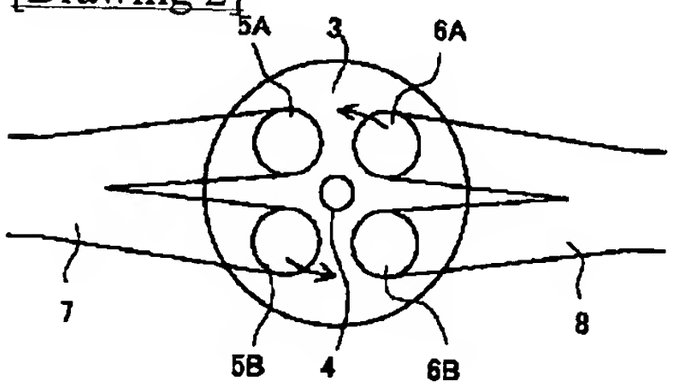
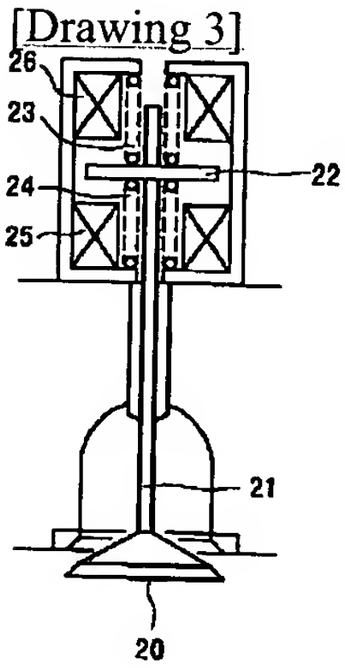
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

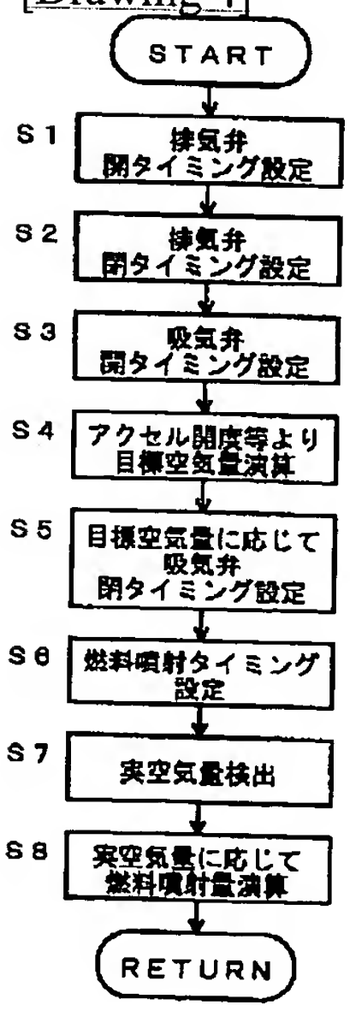
[Drawing 2]



[Drawing 3]



[Drawing 4]



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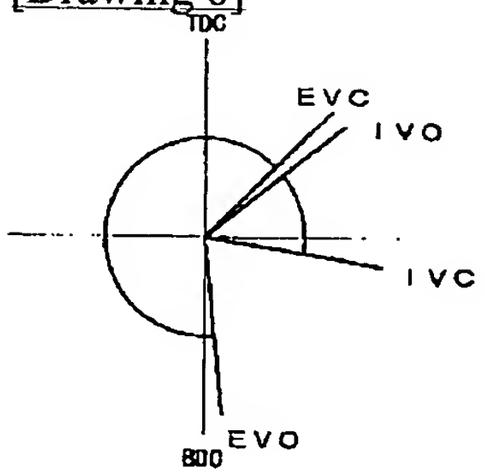
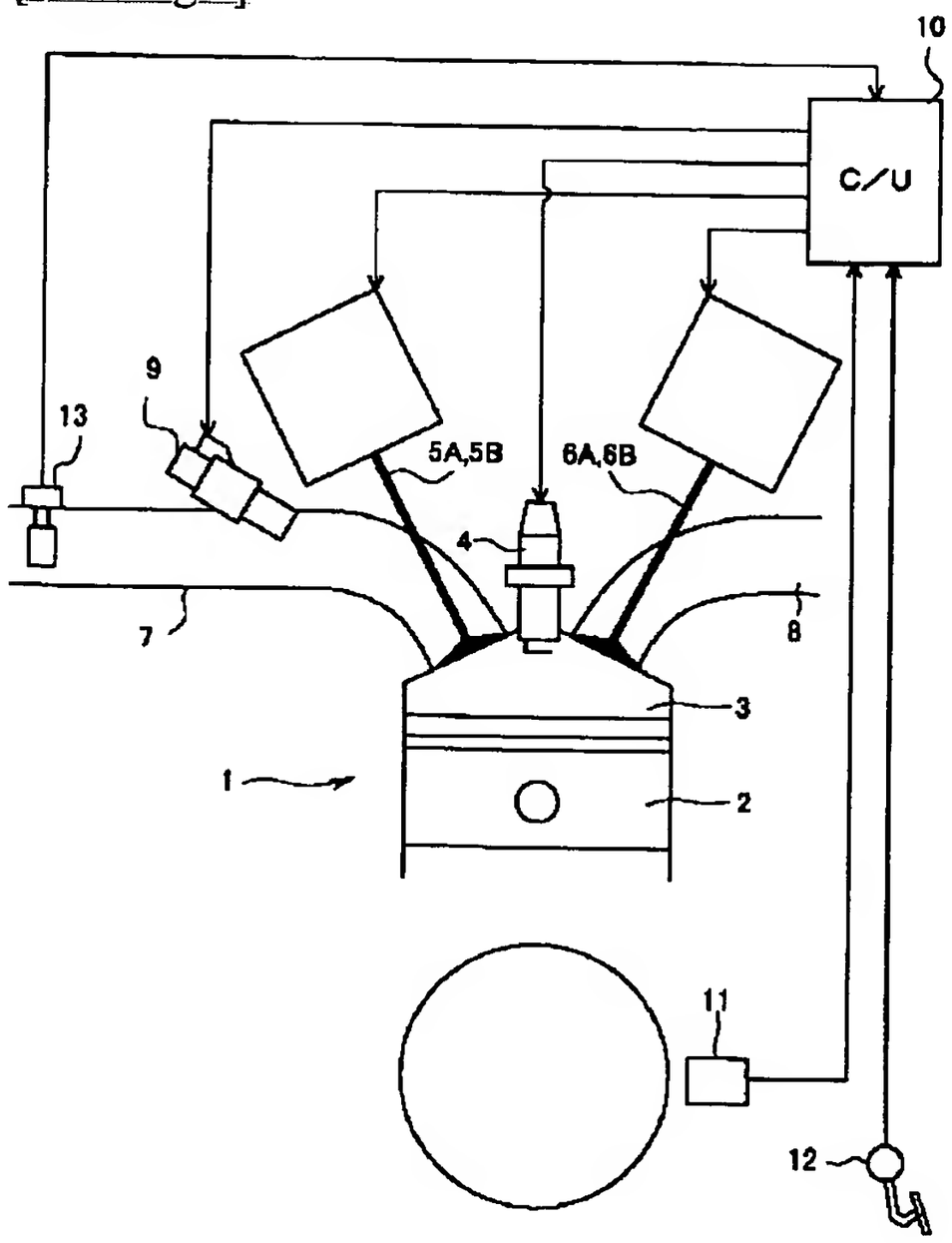


[Drawing 1]



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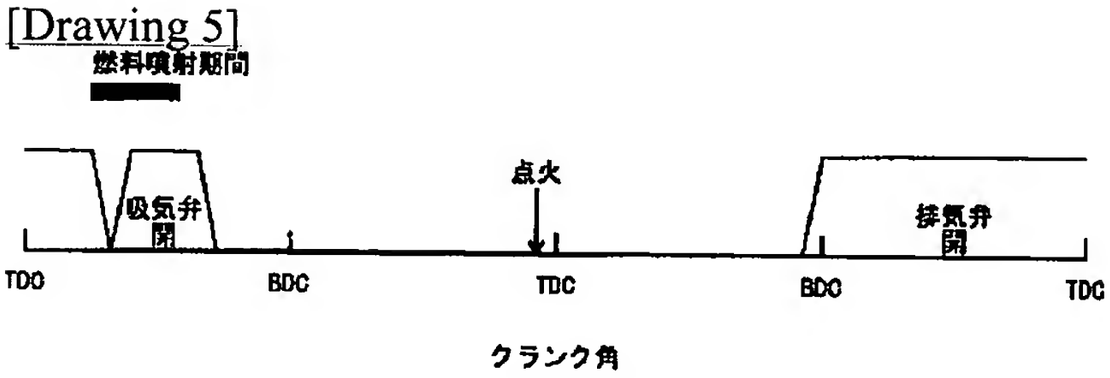
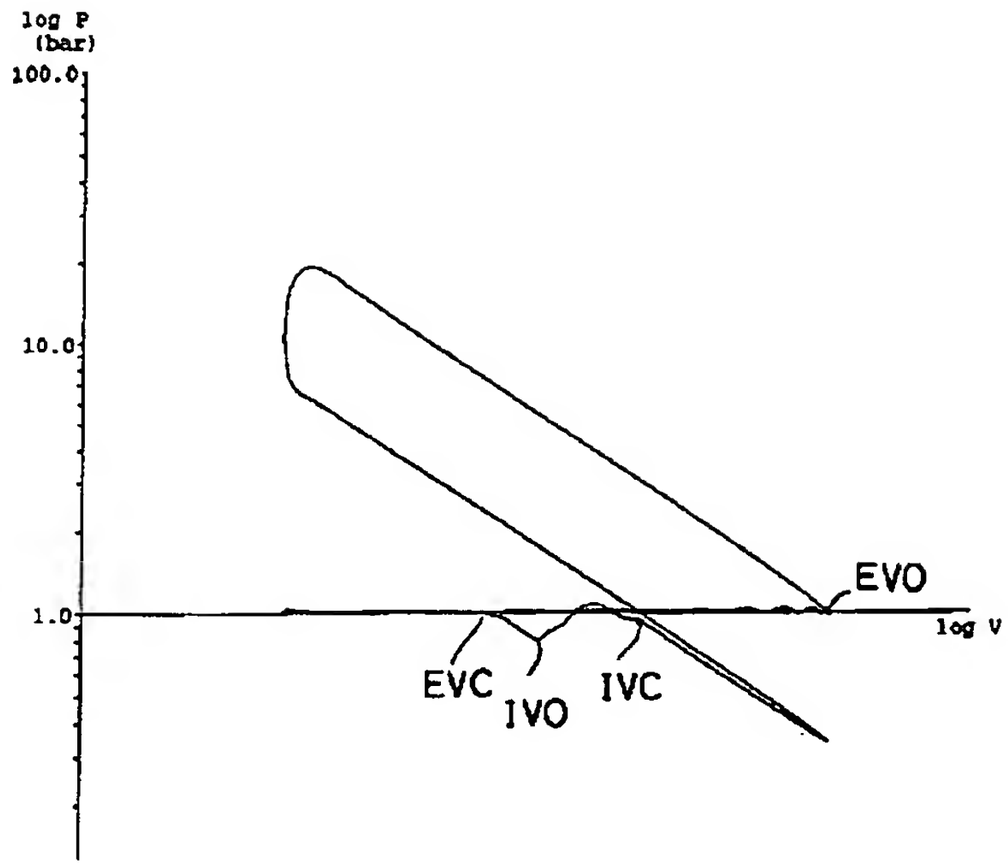
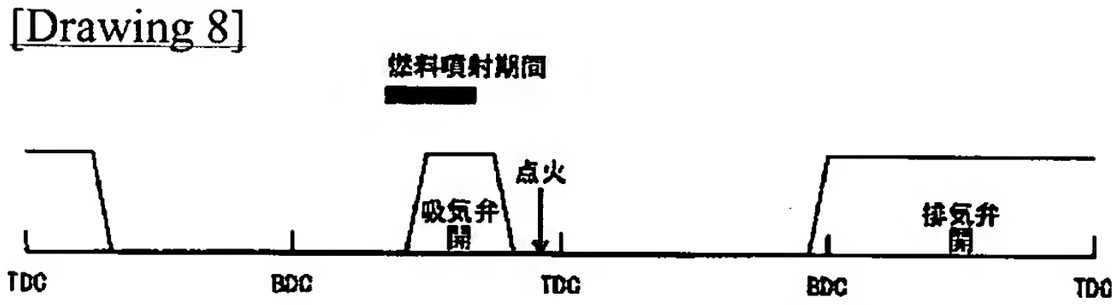


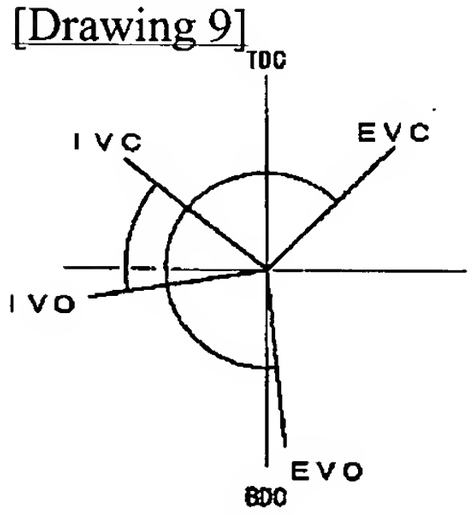
[Drawing 7]



[Drawing 8]

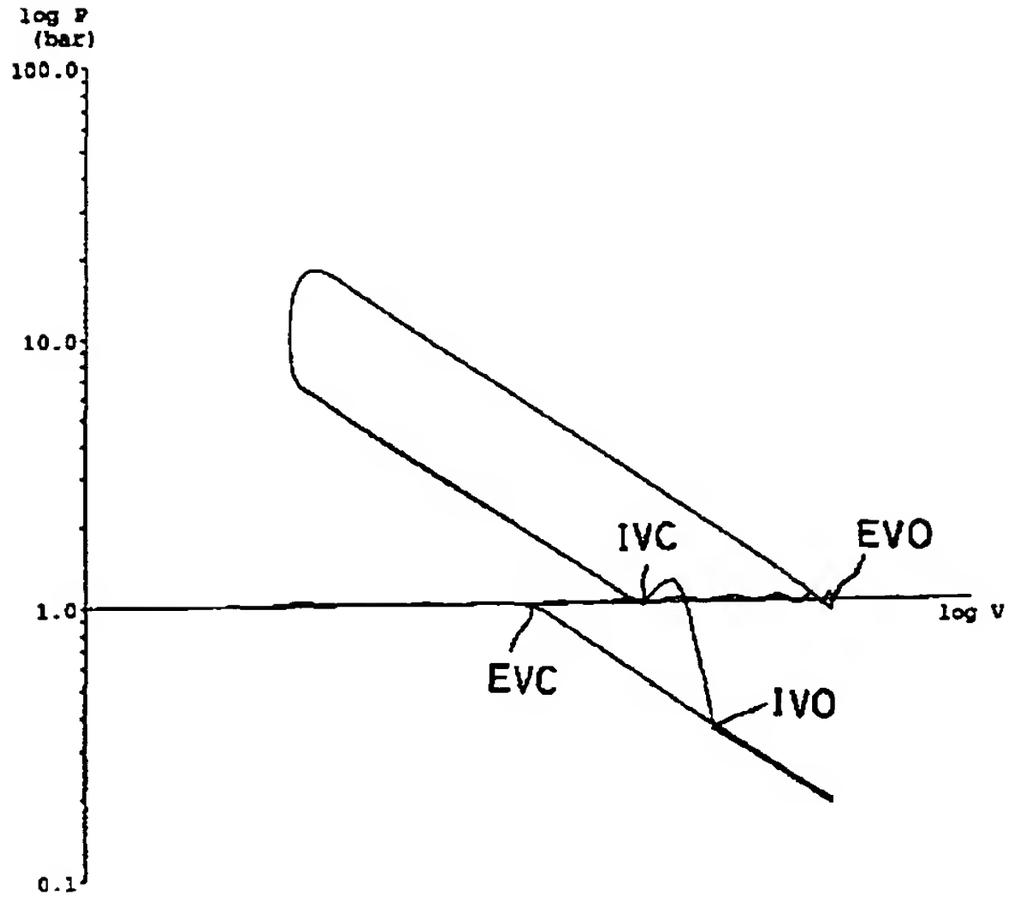


[Drawing 9]



[Drawing 11]

[Drawing 10]



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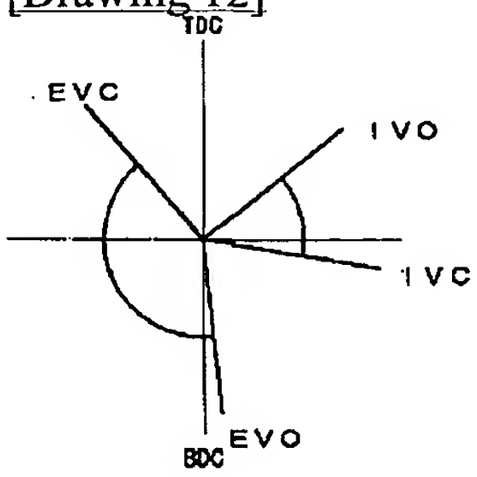

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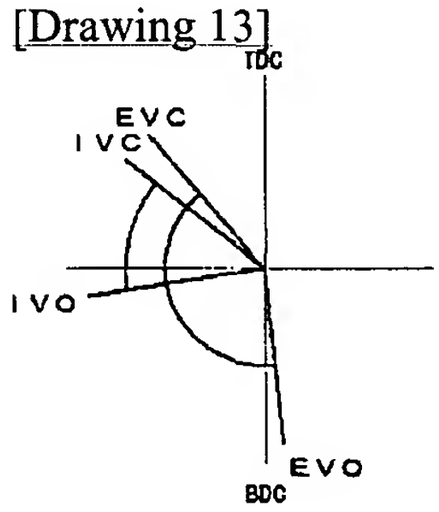

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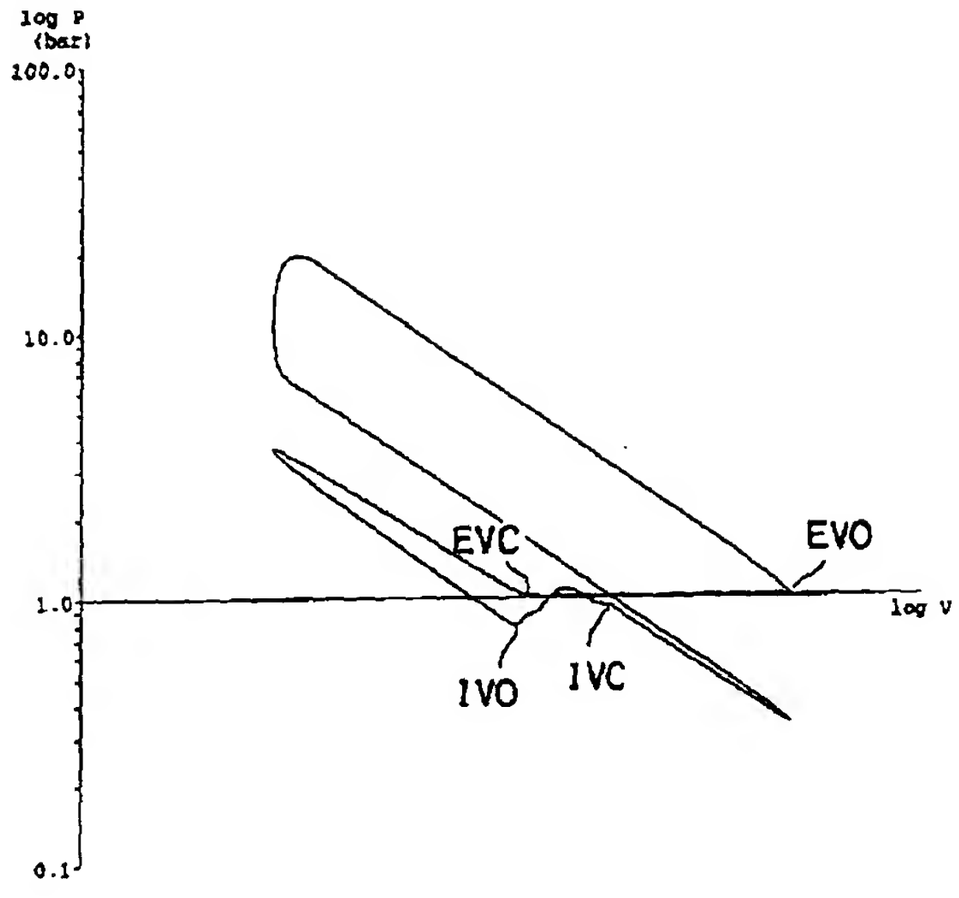
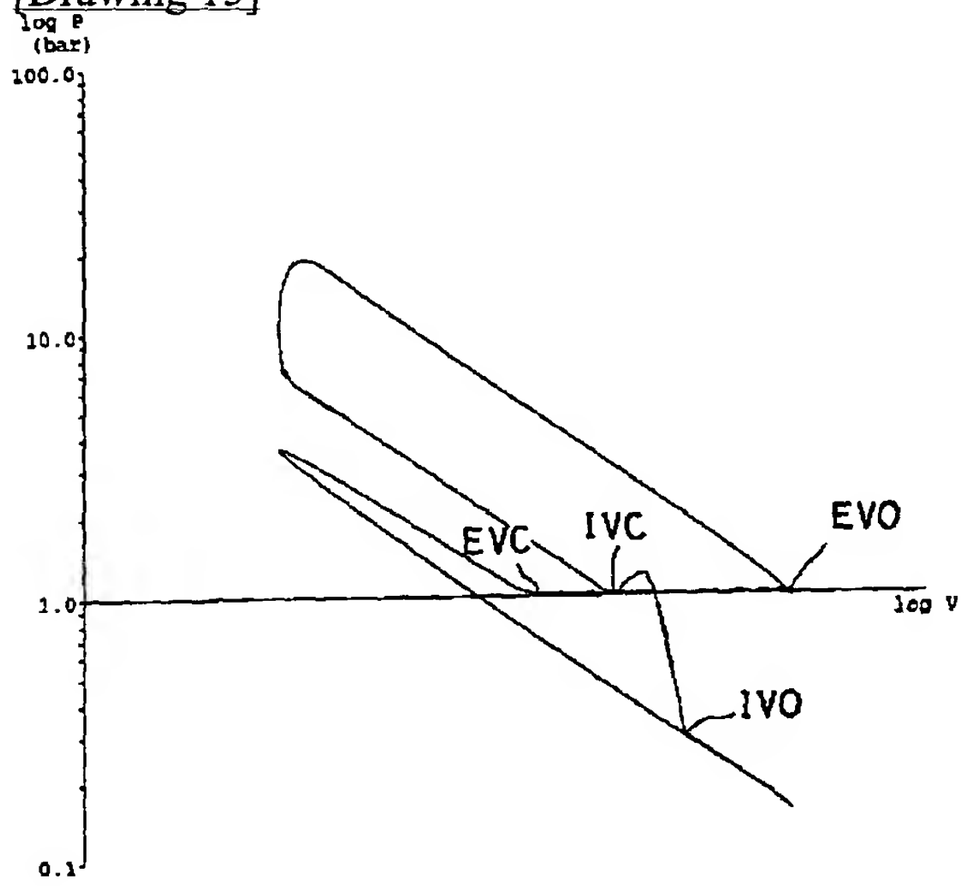


[Drawing 15]



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